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Technical Report No. 44

SACLANT ASW RESEARCH CENTRE

AN INSTRUMENT FOR MEASURING EVAPORATION

by

Allen H. Schooley

1 SEPTEMBER 1965

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VIALE SAN BARTOLOMEO, 92
LA SPEZIA, ITALY

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APPROVED FOR DISTRIBUTION

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Director

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By

A. H. Schooley

ABSTRACT

An evaporation rate meter, or evaporimeter, has been devised that shows promise of directly measuring the rate of evaporation near the sea surface. The simplicity of the instrument indicates that it may be of interest to oceanographers, and possibly to meteorologists and climatologists.

INTRODUCTION

According to von Arx (Ref. 1) the amount of water distilled into the atmosphere from the sea has been estimated by measuring the evaporation from pans of water on shipboard, by meteorological measurements of the upward flux of water vapour in the air above the sea, and by evaluating the successive terms in the steady-state heat budget for the oceans.

It appears that a simpler and more direct method of evaporation measurement is desireable. It is believed that the evaporimeter herein described may be a helpful tool in evaporation studies. The instrument described has only recently been devised and has not yet been used at sea. Early pubblication has been advised because of the instrument's simplicity and its possible application by others.

1. PRINCIPLE OF OPERATION

Figure 1 is a schematic, cross-sectional view of the instrument. The left-hand side of the plastic tube is filled with water contained between a porous filter and a thin cork disk. By wick action, the porous filter presents a continuously wet surface at the left-hand opening of the tube where evaporation occurs. The cork disk fits loosely in the plastic tubing. As its left-hand surface is wetted by the water, but its right-hand surface — being coated with beeswax — is not wetted, capillary forces tend to hold the disk at the water surface. A wire pointer attached to the disk serves both to hold the disk perpendicular to the axis of the tubing and to indicate — along the scale at the right — the position of the water surface.

Models of the evaporimeter have been made both with plastic tubes of 3 mm internal diameter and with those of 5 mm internal diameter. When the material of the tubing can not be wetted by the water, there is very little tendency for water to seep past a cork disk fitting loosely inside such sized tubes. The disk will recover to its stable position (to within about 0.1 mm) even when it is forced in either direction by as much as 0.5 mm. The disk's adherence to the water surface is sufficient for it to remain in position when the tubing is held either straight up or straight down. Even in these positions, moderate jarring will not break the disk away from the water surface. Although the device will work at any angle, it is thought that approximately horizontal operation is probably best, thereby minimizing any effect that the varying head of water in the tube might have as evaporation progresses.

For making measurements, the filter end of the tube is exposed to the environment in which evaporation is to be measured. The obstruction of the cork disk impedes air circulation and minimizes evaporation loss from the other end of the water column. If the evaporation-surface area of the porous filter is assumed to be the same as the cross-sectional area of the water in the tube, differences with time of the scale readings will indicate the evaporation rate in unit scale length per unit time. The sensitivity of the instrument can be changed by changing the ratio between these two areas: greater sensitivity being obtained by proportionally increasing the evaporation-surface area of the filter. It is conceivable that a series of caps with various sized holes in their ends could be made to fit over the filter end of the tubing to give selected evaporation areas and, hence, various sensitivities.

The evaporimeter is refilled, when necessary, by letting it soak in distilled water of the required depth, filter end down. It can also be filled by the use of a thin hypodermic needle inserted through the filter, or by removing the cork disk and filling through a long hypodermic needle.

2. WORKING MODEL

Figure 2 shows one embodiment of the evaporimeter. In this case the scale is mounted below the water-filled tube so that the position of the cork disk can be read directly at any time. A further 5 cm of the plastic tubing on the right-hand side has had approximately a quarter of its diameter removed to leave a channel in which a narrow strip of pressure-sensitive recorder paper can be placed.

Riding lightly on top of this recording paper is a black epoxy bead formed on one end of a wire that is attached at its other end to the cork disk. Just above the bead is a 3 mm diam, 4.5 cm long, brass tube that may be pressed down on the bead by activating an electromagnet attached to the back of the instrument. This action causes the epoxy bead to make a round mark or point on the recording paper below.

By activating the electromagnet at suitable time intervals and noting the distance between the points on the paper, the rate of evaporation may be determined. It is expected that for most work it would be desirable to activate the magnet at fixed time intervals, the length of which would be adjusted for the experiment being made. The electromagnet could be replaced with a mechanical clockwork system if desired.

Figure 3 shows a strip record of evaporation in the laboratory over a 63 hr time period. The small divisions are approximately 1 mm. The total evaporation rate in this case is slightly greater than 0.5 mm/hr.

3. APPLICATIONS

The author has been making measurements at sea of the temperature gradients in the first 10 cm of water below the surface and, simultaneously, in the first 10 cm of air above the surface (Refs. 2 & 3). A small plastic float has been used as the instrument platform. It is intended to augment these measurements with the addition of a more refined version of the evaporimeter. Experience has shown that there is a considerable amount of time in the Mediterranean during which such an instrument could be mounted about 10 cm above the sea surface without it becoming appreciably affected by spray. For such use the evaporimeter will be shielded from radiation heating and mounted in such a way as to minimize the effect of spray without impeding the air flow.

It is also visualized that several evaporimeters at various heights above the sea (or land) may give information that would be of interest to meteorologists and climatologists.

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1. W.S. von Arx, "An Introduction to Physical Oceanography", Addison-Wesley Publ. Co., 1962, p. 187.

2. A.H. Schooley, "Simple Instrumentation for Measuring Temperature Gradients at the Sea-Air Interface", Proc. Ocean Science & Ocean Eng. Conf., Washington D.C., 1965.

3. A.H. Schooley, "Simple Instrumentation for Measuring Temperature Gradients at the Sea-Air Interface", SACLANTCEN T.R. 35, 1965, NATO UNCLASSIFIED.

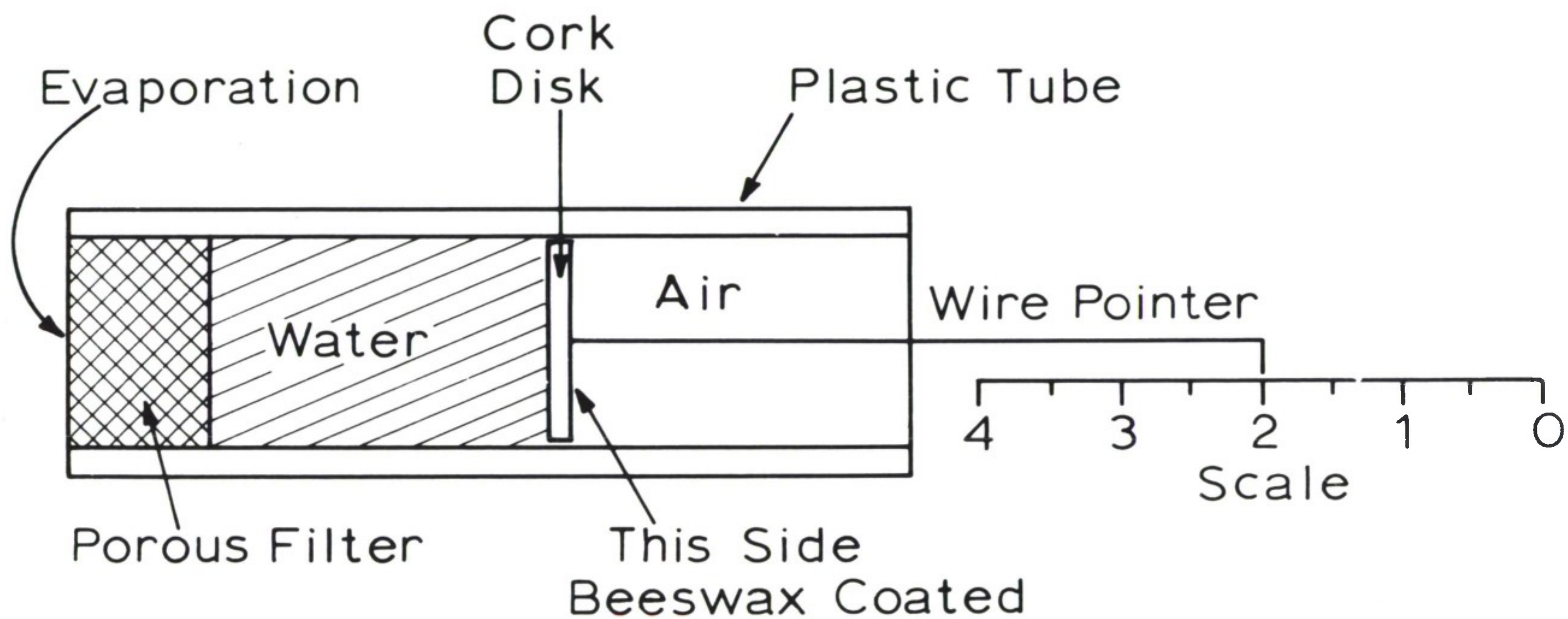

Fig. 1 – SECTIONAL SKETCH OF THE EVAPORIMETER

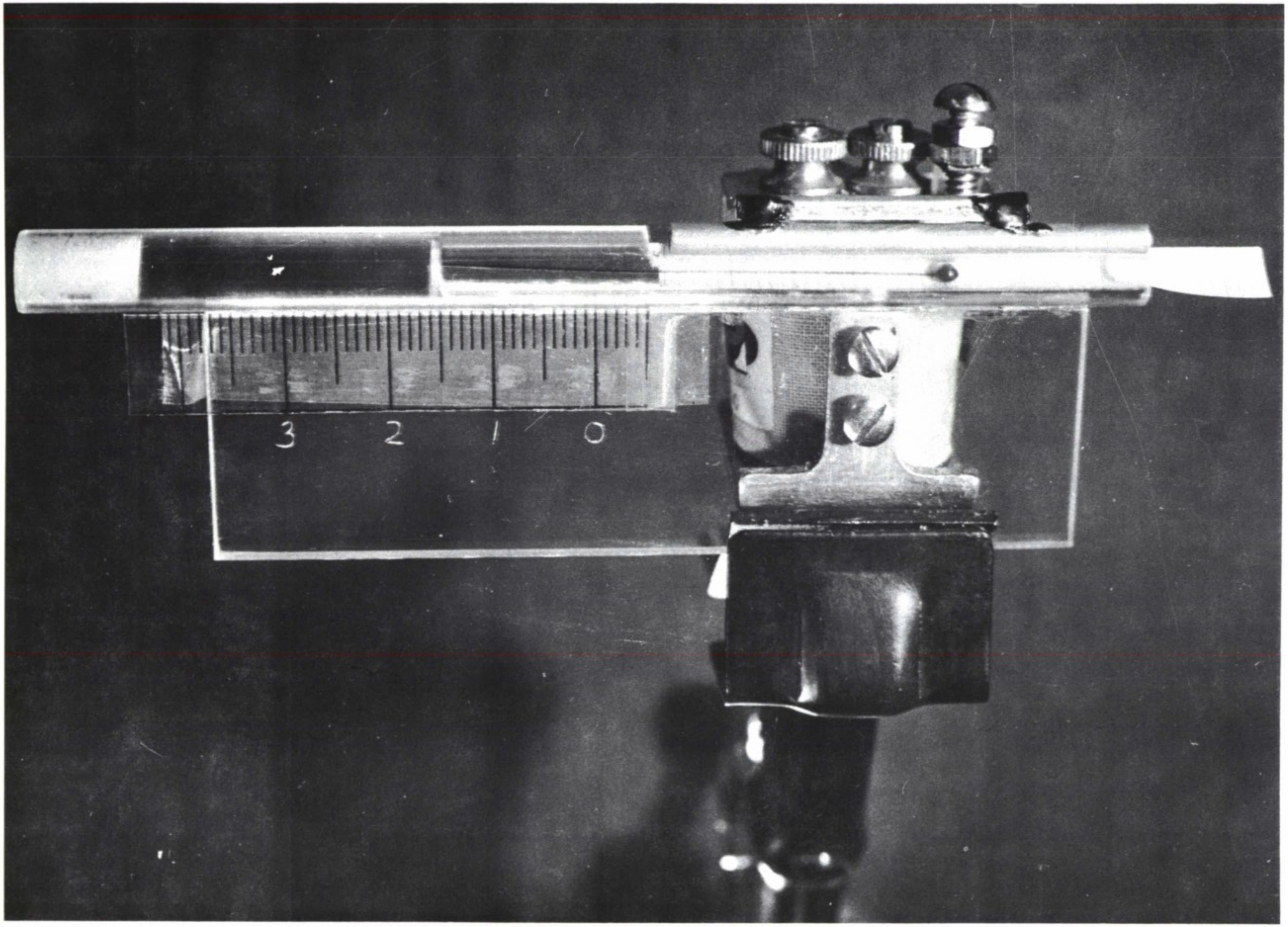

Fig. 2 — WORKING MODEL OF THE EVAPORIMETER

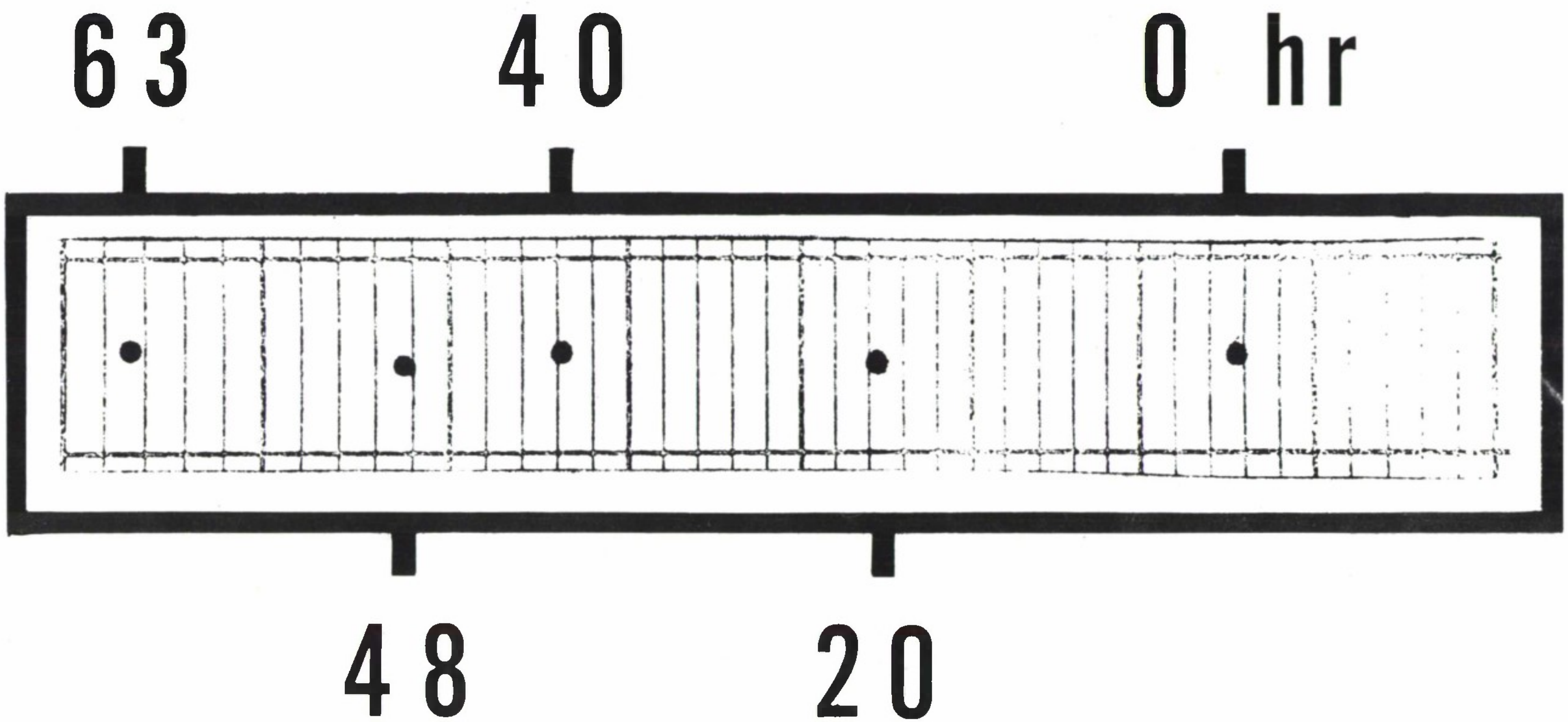

Fig. 3 — A SAMPLE EVAPORIMETER RECORD

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